KOÇ ÜNİVERSİTESİ

Data Structure - Dictionaries

Adopted from Stanford Uni’s CS106ap course slides by Kylie Jue and Sonja Johnson-Yu

Today’s questions

How can I organize my data so it’s easier to use?

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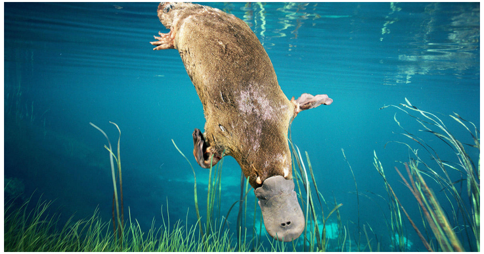
Think/Share:

Store names of habitat animals and their corresponding diet



elephant bear otter platypus

clams grass shrimp berries

Task - Relating data with each other

```
['elephant', ‘bear', ‘otter', ‘platypus']
['grass', ‘berries', ‘clams’, ‘shrimp']
```

Task - Relating data with each other

```
['elephant', ‘bear', ‘otter', ‘platypus']
['grass', ‘berries', ‘clams’, ‘shrimp']
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These pieces of information are linked!

Task - Relating data with each other

```
['elephant', ‘bear', ‘otter', ‘platypus']
['grass', ‘berries', ‘clams’, ‘shrimp']
```

These pieces of information are linked!

Can we store them so they’re associated with each other?

Dictionaries!

Definition

Dictionary

A container data type that maps “keys” to their associated “values”.

Anatomy of a Dictionary

```
name_of_dic = {}

name_of_dic = {'elephant': 'grass', 'bear': ‘berries',
'otter': ‘clams’, 'platypus': ‘shrimp'}
```

Anatomy of a Dictionary

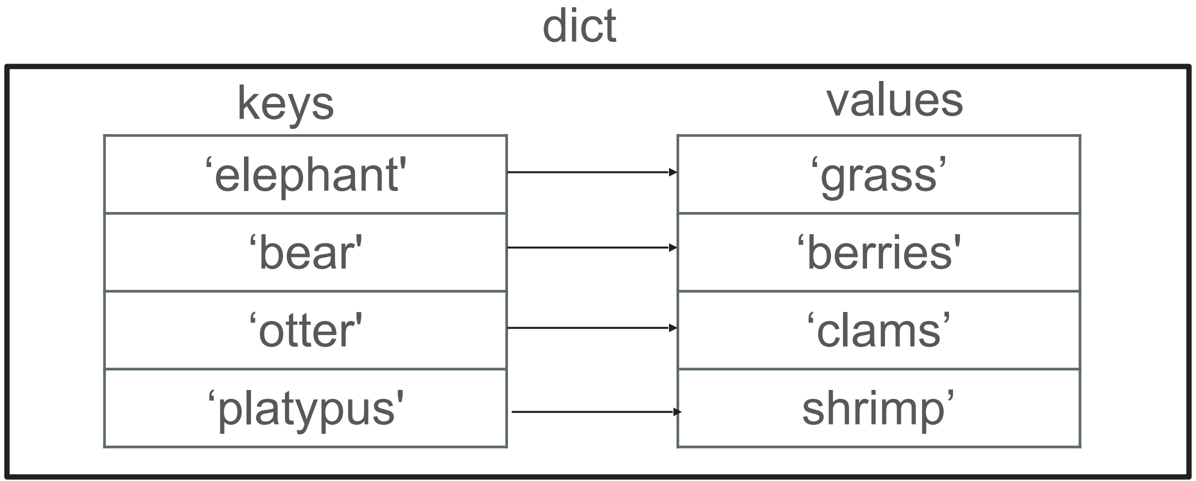
```
name_of_dic = {'elephant': 'grass', 'bear': ‘berries',
'otter': ‘clams’, 'platypus': ‘shrimp'}
```

This is a dictionary literal

Anatomy of a Dictionary

```
name_of_dic = {'elephant': 'grass', 'bear': ‘berries',
'otter': ‘clams’, 'platypus': ‘shrimp'}
```

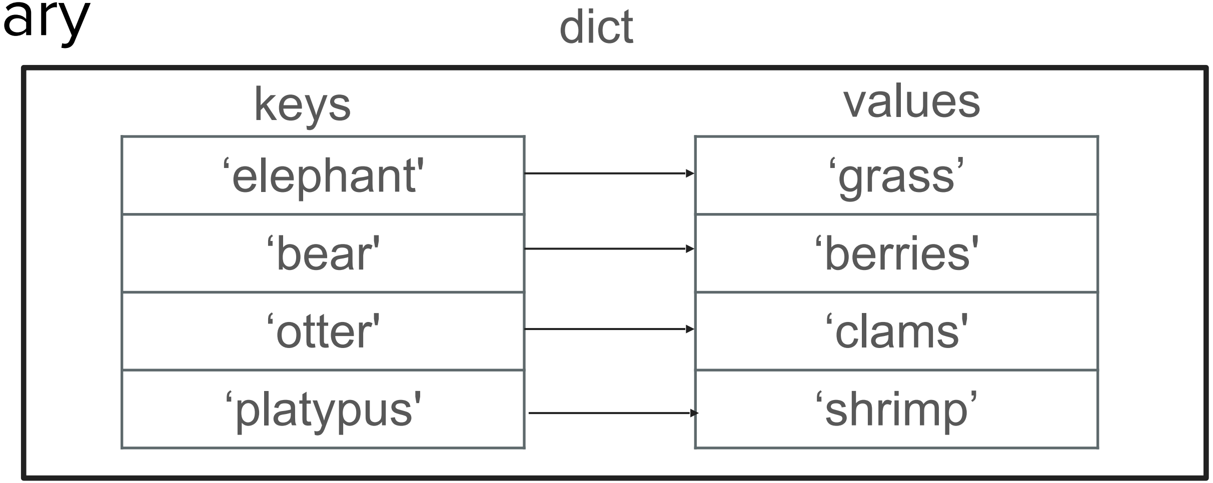
It is easier to visualize it this way:



dict

keys	values
‘elephant'	‘grass’
‘bear'	‘berries'
‘otter'	‘clams’
‘platypus'	shrimp’

Anatomy of a Dictionary



dict

keys	values
‘elephant'	‘grass’
‘bear'	‘berries'
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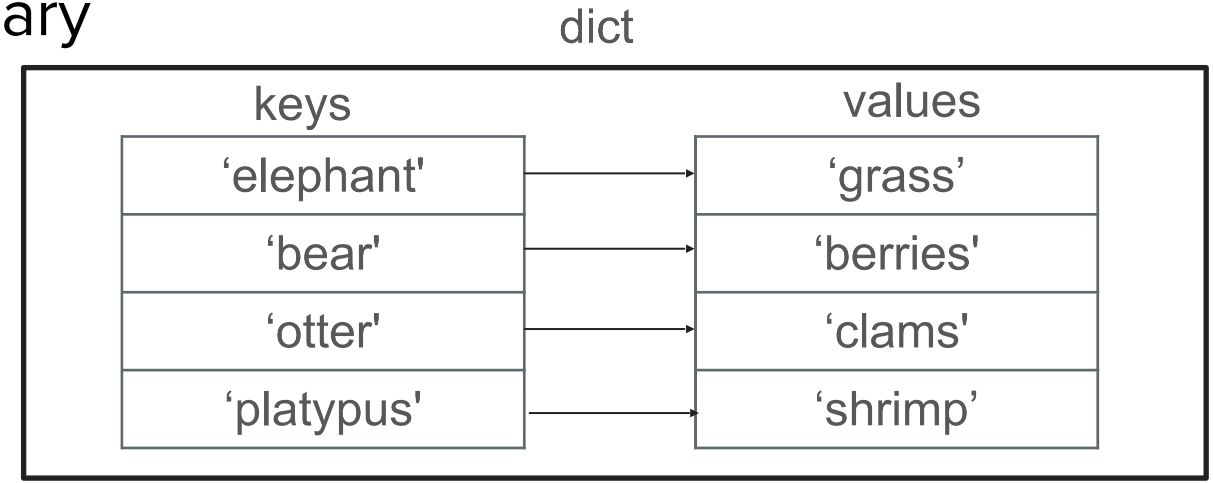
‘platypus'	‘shrimp’

Each key can store one value

Anatomy of a Dictionary

```
>>> d[‘elephant’]
```



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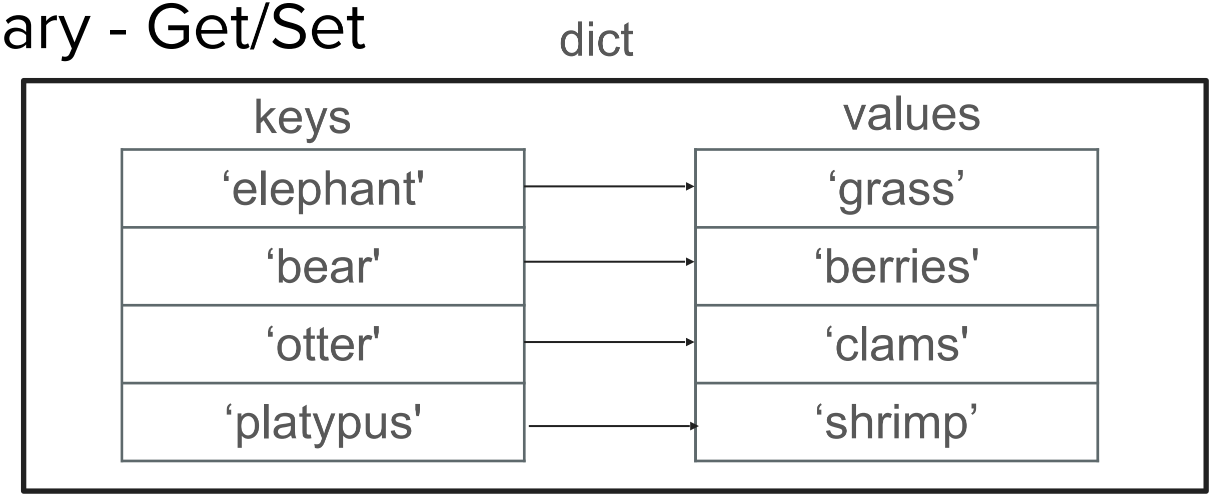
Each key can store one value

Anatomy of a Dictionary - Get/Set

```
>>> d[‘elephant’]
```

This operation is called “get”



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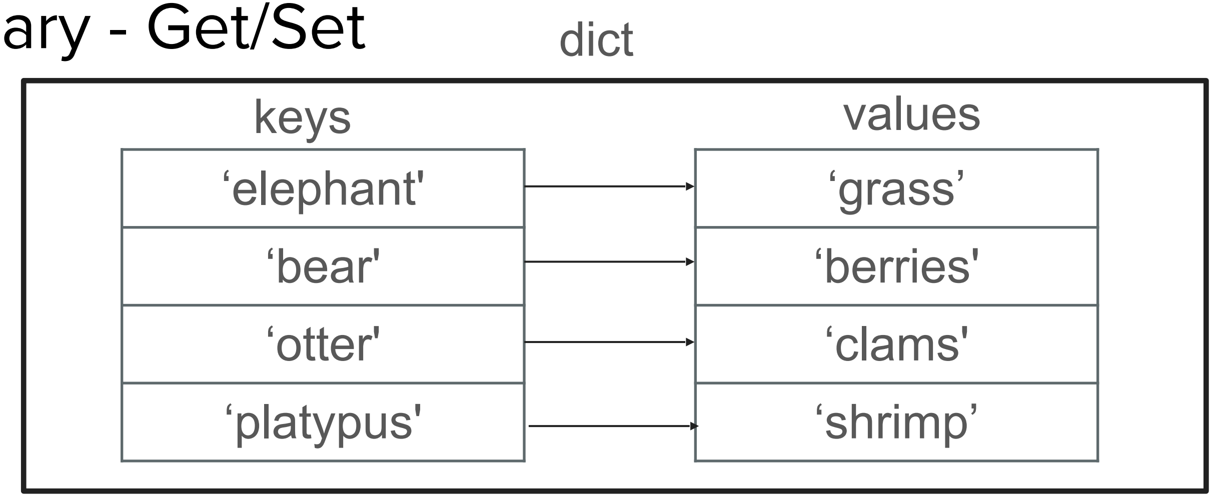

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‘bear'	‘berries'
‘otter'	‘clams'
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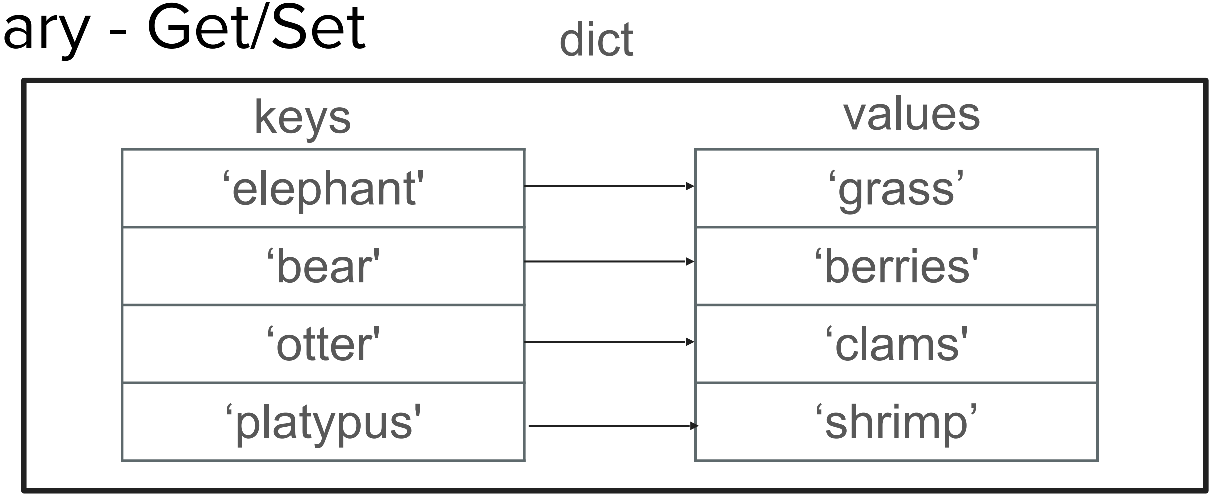
Anatomy of a Dictionary - Get/Set

```
>>> d[‘elephant’]

‘grass’
```



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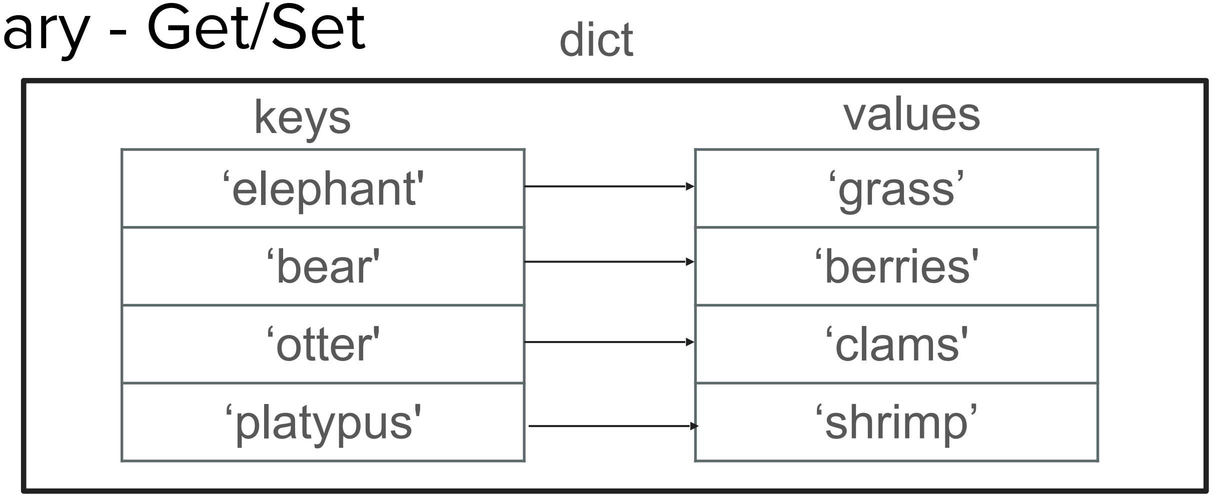
Anatomy of a Dictionary - Get/Set

```
>>> d[‘elephant’]

‘grass’
```



dict

keys	values
‘elephant'	‘grass’
‘bear'	‘berries'
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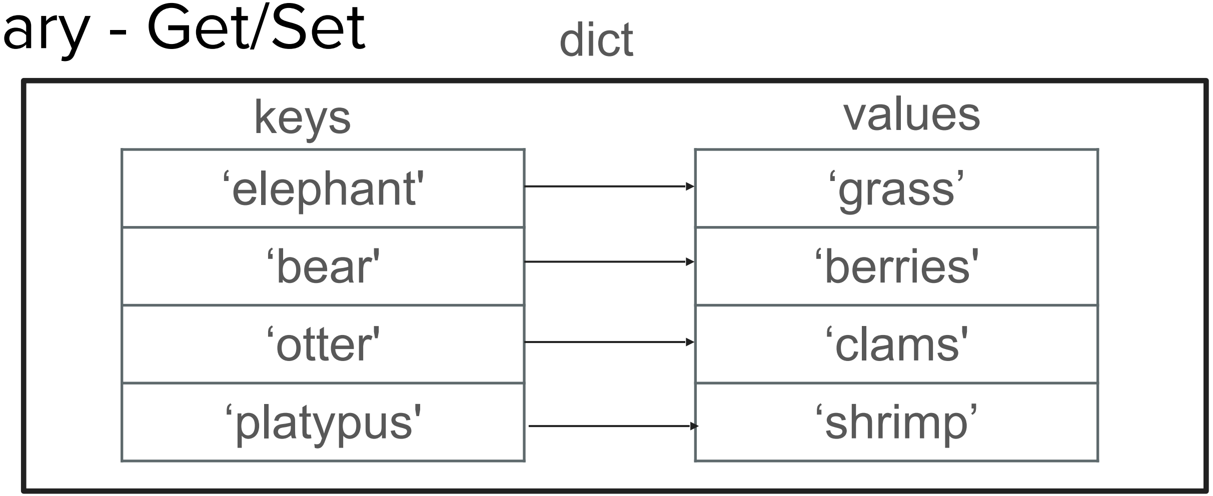
‘platypus'	‘shrimp’

Anatomy of a Dictionary - Get/Set

```
>>> d['elephant']

'grass'
```



dict

keys	values
‘elephant'	‘grass’
‘bear'	‘berries'
‘otter'	‘clams'
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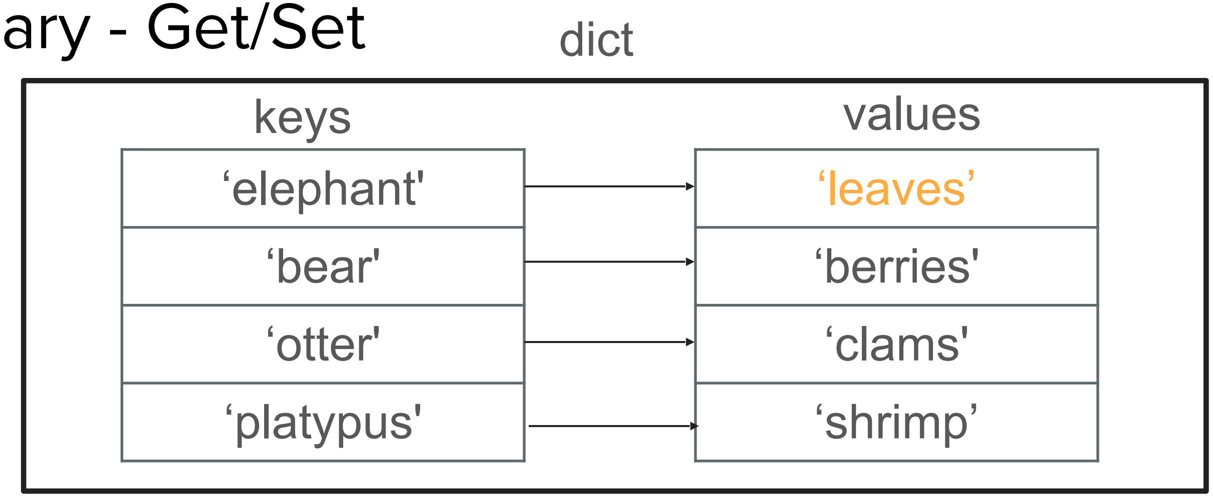
```
>>> d['elephant'] = 'leaves'
```

This operation is called “set”

Anatomy of a Dictionary - Get/Set

```
>>> d['elephant']

'grass'
```



dict

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```
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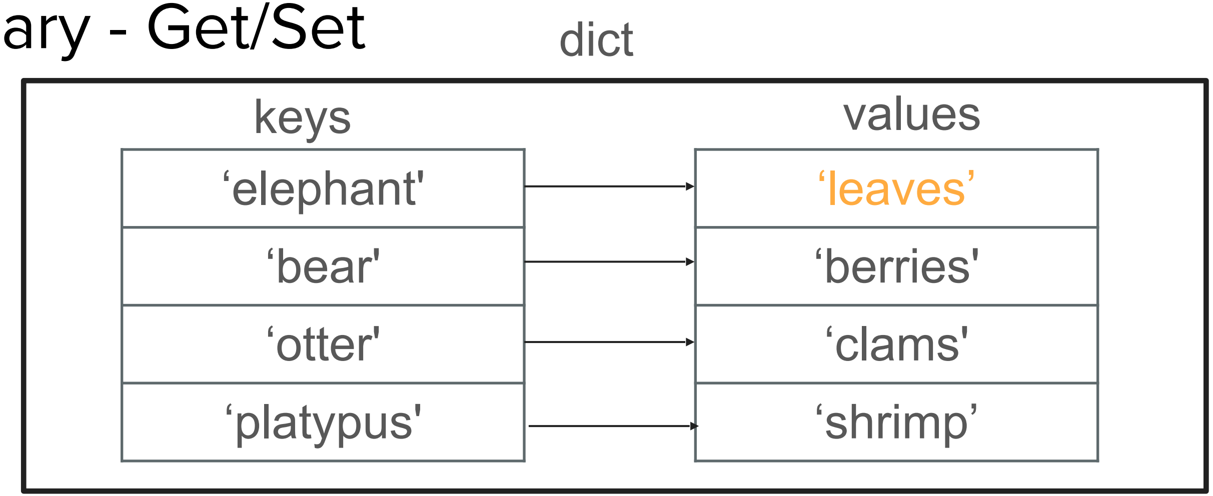
```

This operation is called “set”

Anatomy of a Dictionary - Get/Set

```
>>> d[‘elephant’]

‘grass’
```



dict

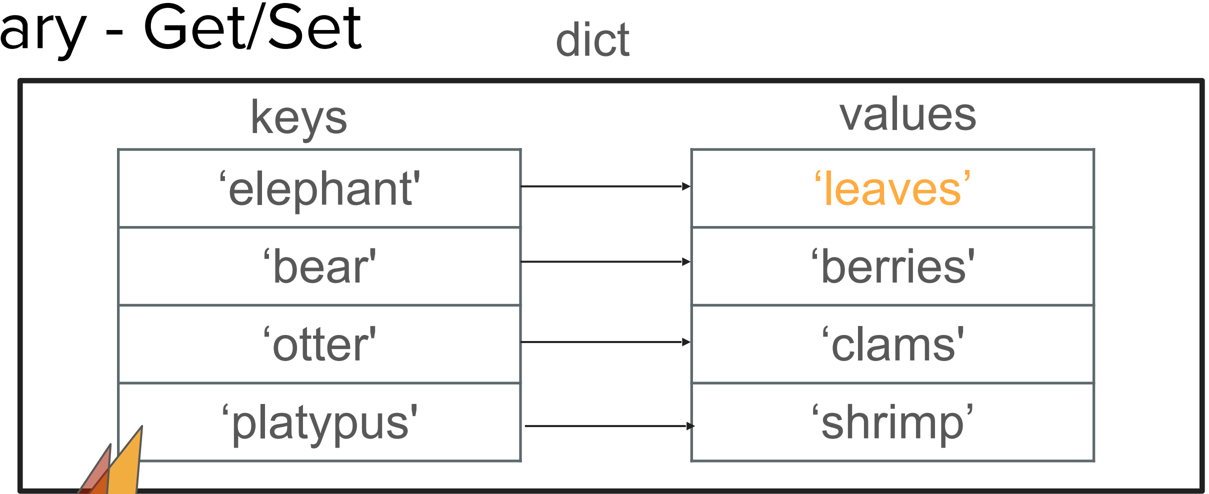
keys	values
‘elephant'	‘leaves’
‘bear'	‘berries'
‘otter'	‘clams'
‘platypus'	‘shrimp’

```
>>> d[‘elephant’] = ‘leaves’
>>> d[‘cat’]
```

Anatomy of a Dictionary - Get/Set

```
>>> d['elephant']
```

```
'grass'
```



dict

keys	values
'elephant'	'leaves'
'bear'	'berries'
'otter'	'clams'
'platypus'	'shrimp'

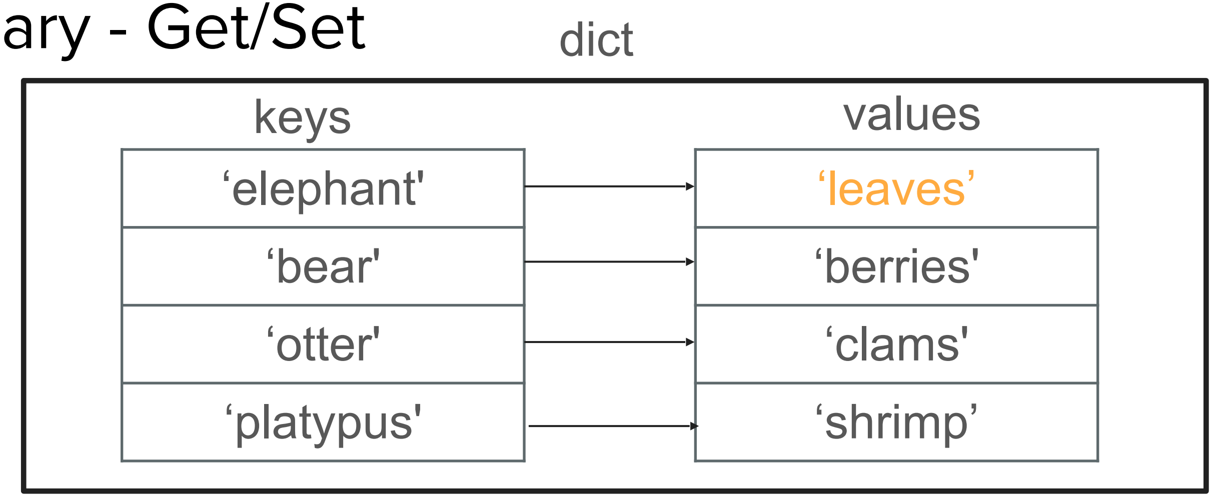
```
>>> d['elephan              s'
>>> d['cat']
```

KeyError

Anatomy of a Dictionary - Get/Set

```
>>> d[‘elephant’]

‘grass’
```



dict

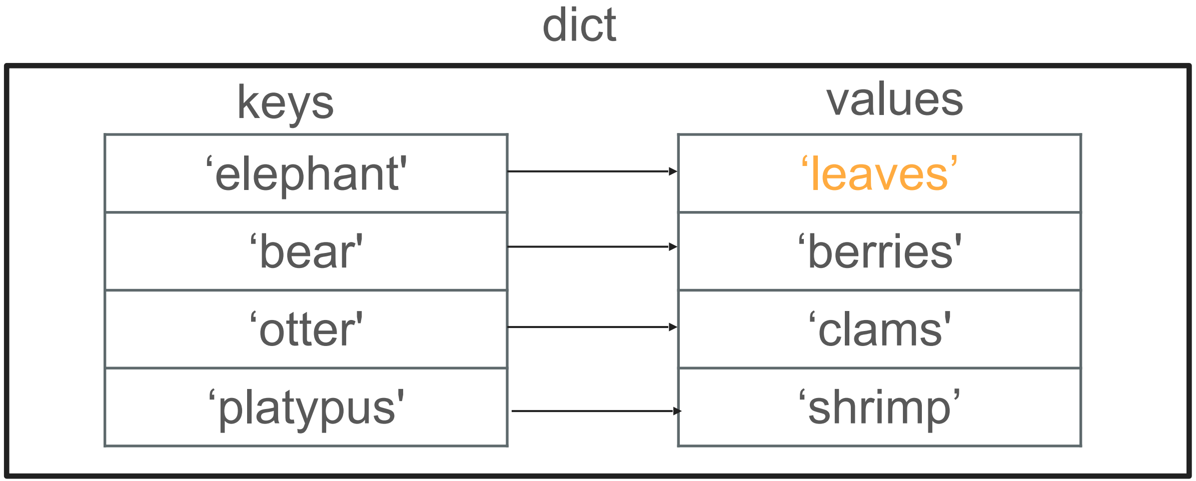
keys	values
‘elephant'	‘leaves’
‘bear'	‘berries'
‘otter'	‘clams'
‘platypus'	‘shrimp’

```
>>> d[‘elephant’] = ‘leaves’
>>> d[‘cat’]
```

“get” errors if the key is not in the dict

Dictionary - **in**

```
>>>‘elephant’ in d
```

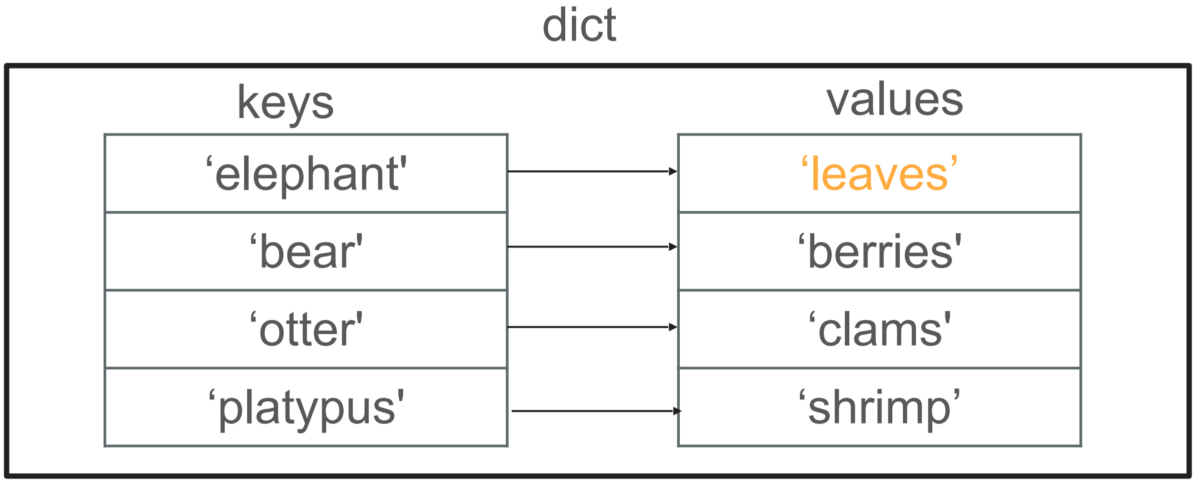


dict

keys	values
‘elephant'	‘leaves’
‘bear'	‘berries'
‘otter'	‘clams'
‘platypus'	‘shrimp’

Dictionary - **in**

```
>>>‘elephant’ in d
True
```



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‘elephant'	‘leaves’
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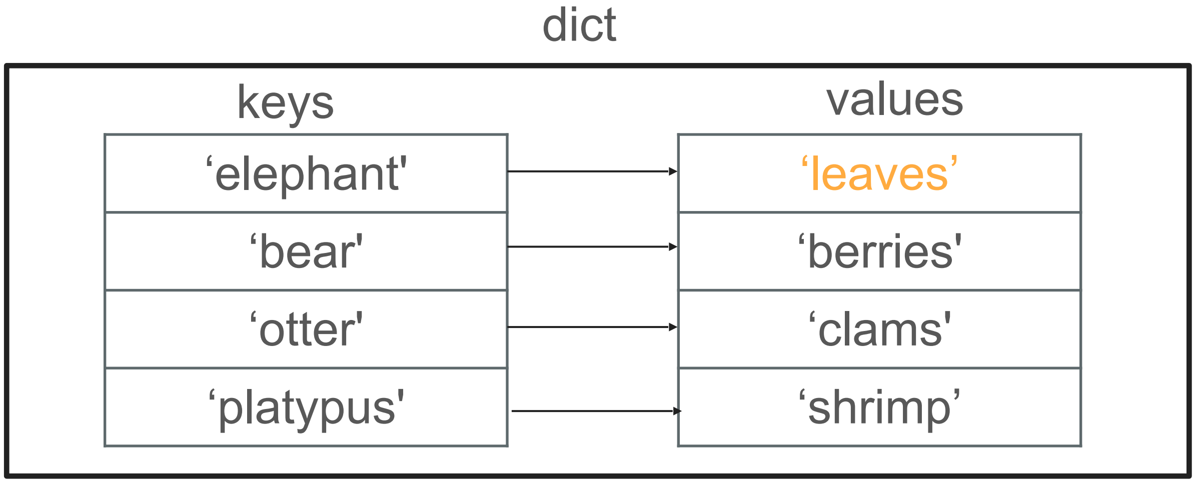
‘platypus'	‘shrimp’

Dictionary - **in**

```
>>>‘elephant’ in d
True
>>>‘cat’ not in d
True
```



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Dictionary - **in**

```
>>>‘elephant’ in d
True
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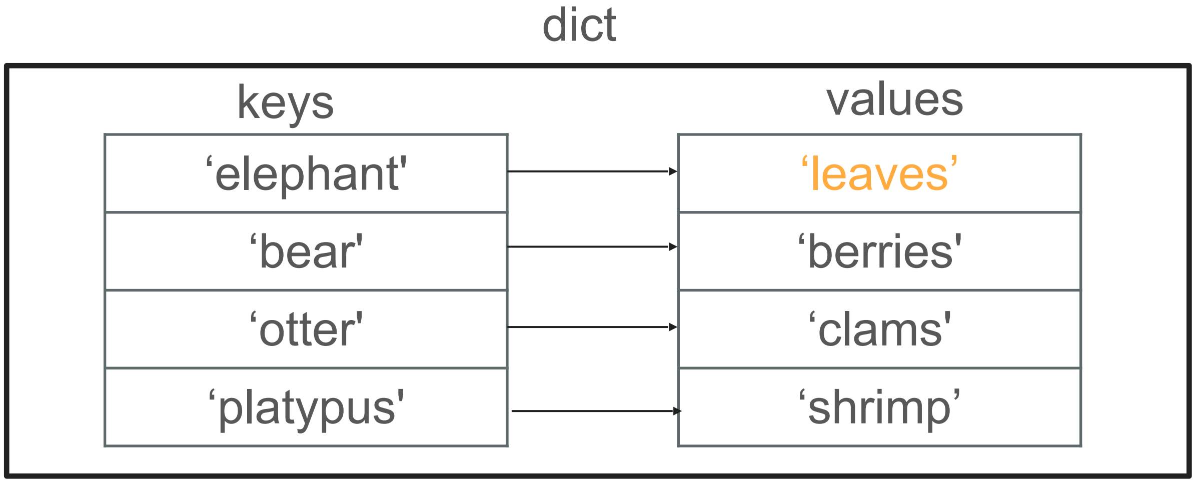
True
```



dict

keys	values
‘elephant'	‘leaves’
‘bear'	‘berries'
‘otter'	‘clams'
‘platypus'	‘shrimp’

Common pattern: Check if key is present. If it is, do something. If it isn’t, do something else.

Building a dictionary

```
>>> d = {}
```

Building a dictionary

```
>>> d = {}
```

Create an empty dictionary

Building a dictionary

```
>>> d = {}

>>> d[‘elephant’] = ‘grass’
```

Building a dictionary

```
>>> d = {}

>>> d[‘elephant’] = ‘grass’
```

We can add keys using “set”

Building a dictionary

```
>>> d = {}

>>> d[‘elephant’] = ‘grass’

>>> d
```

We can add keys using “set”

Building a dictionary

```
>>> d = {}

>>> d[‘elephant’] = ‘grass’

>>> d
{‘elephant’: ‘grass'}
```

We can add keys using “set”

Building a dictionary

```
>>> d = {‘elephant’: ‘grass’}
```

Types of Dictionaries

- So far, we’ve seen dictionaries mapping from strings to ints
  - This is not the only type of dictionary!
  - You can map from string/int/float to string/int/float…

Think/Share:

Store names of CS lecturers and their ages

Accessing a Dictionary’s Keys

```
>>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}
```

Building a dictionary

```
>>> d = {‘Ayca’: 34}

>>> d[‘Ayca’] += 2
```

Building a dictionary

```
>>> d = {‘Ayca’: 34}

>>> d[‘Ayca’] += 2
```

we can get/set on the same line!
(same as d[‘Ayca’] = d[‘Ayca] + 2)

Building a dictionary

```
>>> d = {‘Ayca’: 34}

>>> d[‘Ayca’] += 2

>>> d[‘Ayca’]
{‘Ayca’: 36}
```

we can get/set on the same line!
(same as d[‘Ayca’] = d[‘Ayca] + 2)

Accessing a Dictionary’s Keys

```
>>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30,
‘Chris’= 29’}

>>> d.keys()
```

Accessing a Dictionary’s Keys

```
>>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30,
‘Chris’= 29’}

>>> d.keys()
dict_keys([‘Ayca’, ‘Nick’, ‘Ondrej’, ‘Chris’])
```

Iterable collection of all the keys.
Iterable means it can be used in foreach

Accessing a Dictionary’s Keys

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> list(d.keys())
[‘Ayca’, ‘Nick’, ‘Ondrej’, Chris]
```

we are using list() to convert d.keys() into a list

Accessing a Dictionary’s Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}
```

Accessing a Dictionary’s Values

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>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> list(d.values())
```

Accessing a Dictionary’s Values

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>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
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Accessing a Dictionary’s Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> list(d.values())
[34,28,30,29]
```

we are using list() to convert d.values() into a list

Looping over a Dictionary’s Keys

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}
```

Looping over a Dictionary’s Keys

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> for name in d.keys():
```

Looping over a Dictionary’s Keys

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> for name in d.keys():
...   print(name)
```

Looping over a Dictionary’s Keys

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> for name in d.keys():
...   print(name)
Ayca
Nick
Ondrej
Chris
```

Looping over a Dictionary’s Keys

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>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> for name in d.keys():
...   print(name)
Ayca
Nick
Ondrej
Chris
```

we can use foreach on the dictionary’s keys!

Looping over a Dictionary’s Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
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Looping over a Dictionary’s Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> for age in d.values():
```

Looping over a Dictionary’s Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> for age in d.values():
...   print(age)
```

Looping over a Dictionary’s Values

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>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> for age in d.values():
...   print(age)
34
28
30
29
```

Looping over a Dictionary’s Values

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>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
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>>> for age in d.values():
...   print(age)
34
28
30
29
```

we can use foreach on the dictionary’s values!

Looping over a Dictionary’s Keys and Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}
```

Looping over a Dictionary’s Keys and Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> for name, age in d.items():
```

Looping over a Dictionary’s Keys and Values

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>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
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>>> for name, age in d.items():
```

items() gives us key, value pairs

Looping over a Dictionary’s Keys and Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> for name, age in d.items():
...   print(name, ‘is’, age, ‘years old.’)
```

items() gives us key, value pairs

Looping over a Dictionary’s Keys and Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}
>>> for name, age in d.items():
...   print(name, ‘is’, age, ‘years old.’)
Ayca is 34 years old.
Nick is 28 years old.
Ondrej is 30 years old.
Chris is 29 years old.
```

items() gives us key, value pairs

Looping over a Dictionary’s Keys and Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}
>>> for name, age in d.items():
...   print(name, ‘is’, age, ‘years old.’)
Ayca is 34 years old.
Nick is 28 years old.
Ondrej is 30 years old.
Chris is 29 years old.
```

print() will automatically concatenate args separated by commas!

Printing with sep=

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> for name, age in d.items():
...   print(name, age, sep=‘: ’)
```

Printing with sep=

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> for name, age in d.items():
...   print(name, age, sep=‘: ’)
```

sep is an optional argument like end!

Printing with sep=

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
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>>> for name, age in d.items():
...   print(name, age, sep=‘: ’)
Ayca: 34
Nick: 28
Ondrej: 30
Chris: 29
```

sep is an optional argument like end!

Printing with sep=

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> for name, age in d.items():
...   print(name, age, sep=‘: ’)
Ayca: 34
Nick: 28
Ondrej: 30
Chris: 29
```

the separating string will be printed between the arguments you pass into print()

Printing with sep=

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’= 29’}

>>> for name, age in d.items():
...   print(name, age, sep=‘: ’)
Ayca: 34
Nick: 28
Ondrej: 30
Chris: 29
```

the default is sep=‘ ’ (insert space)

Getting a Sorted List of Keys

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}
```

Getting a Sorted List of Keys

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> sorted(d.keys())
```

Getting a Sorted List of Keys

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> sorted(d.keys())
[‘Ayca’, ‘Chris’, ‘Nick’, ‘Ondrej’]
```

Getting a Sorted List of Keys

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> sorted(d.keys())
[‘Ayca’, ‘Chris’, ‘Nick’, ‘Ondrej’]
```

sorted() returns a list in alphabetical order!

Getting a Sorted List of Keys

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> sorted(d.keys())
[‘Ayca’, ‘Chris’, ‘Nick’, ‘Ondrej’]
>>> d
```

Getting a Sorted List of Keys

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’= 29’}

>>> sorted(d.keys())
[‘Ayca’, ‘Chris’, ‘Nick’, ‘Ondrej’]
>>> d
[‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’= 29’]
```

Sorting a Dictionary’s Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}
```

Sorting a Dictionary’s Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> sorted(d.values())
```

Sorting a Dictionary’s Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> sorted(d.values())
[28, 29, 30, 34]
```

Sorting a Dictionary’s Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> sorted(d.values())
[28, 29, 30, 34]
```

sorted() returns a list in numerical order!

Retrieving Min/Max Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}
```

Retrieving Min/Max Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> min(d.values())
```

Retrieving Min/Max Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> min(d.values())
```

returns the smallest element!

Retrieving Min/Max Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> min(d.values())
28
```

returns the smallest element!

Retrieving Min/Max Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> min(d.values())
28
>>> max(d.values())
```

returns the smallest element!

Retrieving Min/Max Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}

>>> min(d.values())
28
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returns the smallest element!

returns the biggest element!

Retrieving Min/Max Values

```
>> d = {‘Ayca’: 34, ‘Nick’: 28, ‘Ondrej’: 30, ‘Chris’=
29’}
```

```
>>> min(d.values())
28
>>> max(d.values())
34
```

returns the smallest element!

returns the biggest element!

What’s next?

Think/Share:

Implement a phone book using dictionaries

Nested Data Structures

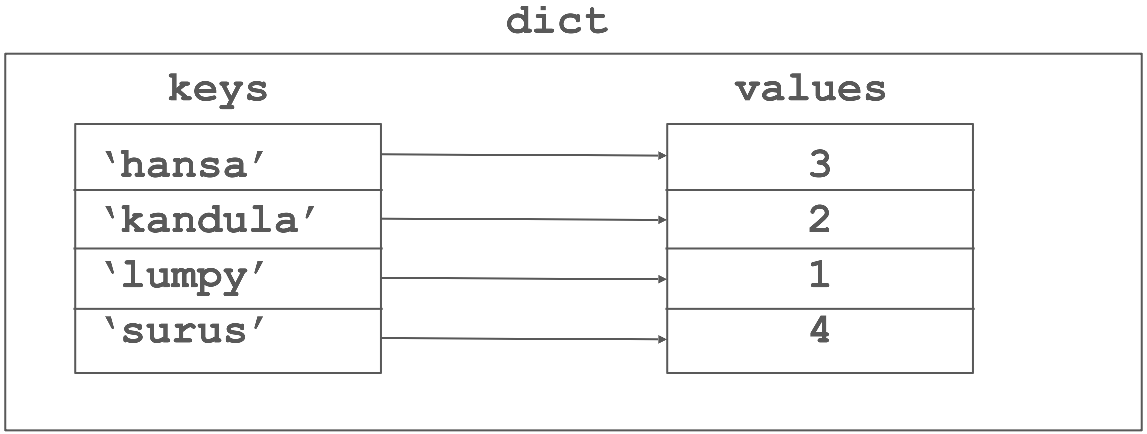
- We can nest data structures!
    - Lists in lists
        - *grid/game board*
    - Lists in dicts
        - *animals to feeding times*
    - Dicts in dicts
        - *your phone’s contact book*
    - ... and so on!

Think/Share:

Make a dictionary of habitat animals and the number of times each animal has been fed.

Animal – Feedings Dictionary

- animal name ⟶ number of feedings
- string ⟶ int

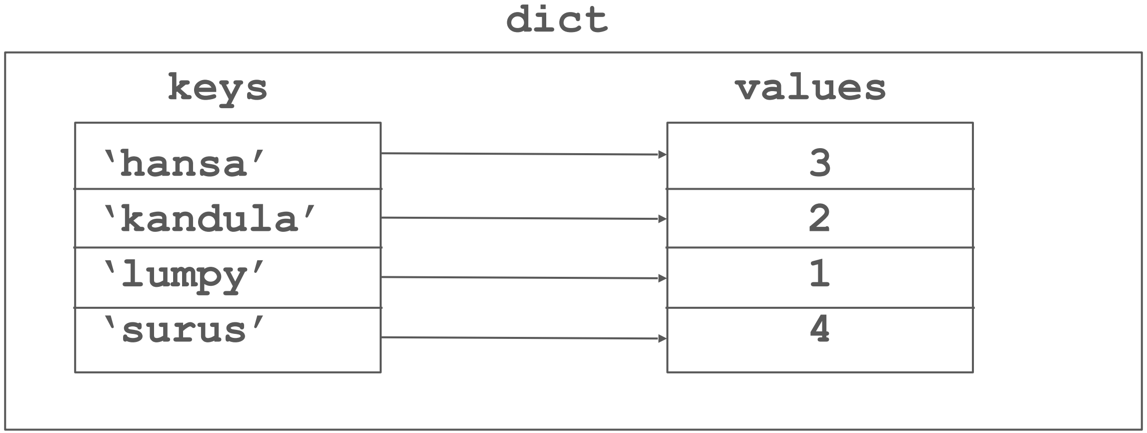


dict

keys	values
'hansa'	3
'kandula'	2
'lumpy'	1
'surus'	4

Recall: Animal – Feedings Dictionary

- animal name ⟶ number of feedings
- string ⟶ int



dict

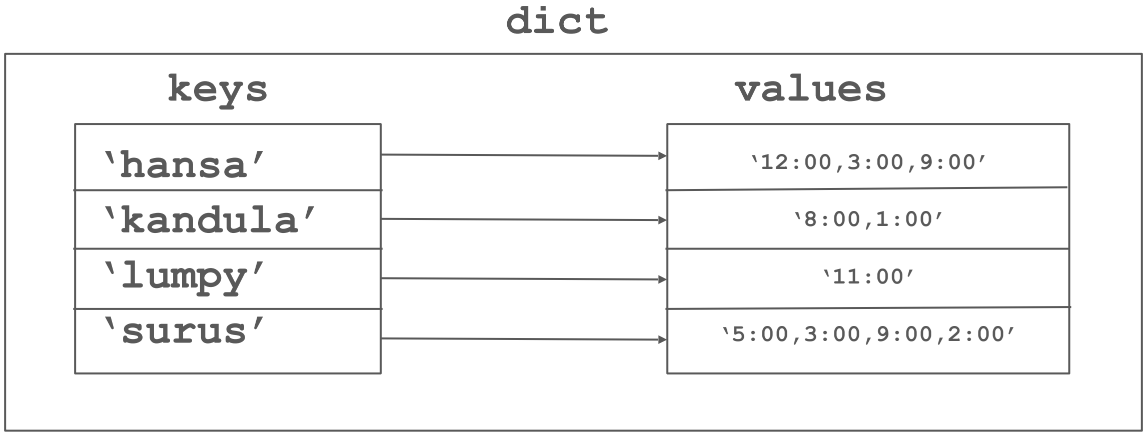
keys	values
‘hansa’	3
‘kandula’	2
‘lumpy’	1
‘surus’	4

What if we wanted to store the **times** that the animals were fed?

Attempt #1: Animal – Feeding Times Dictionary

- animal name ⟶ **feeding times**
- string ⟶ **string**

What if we wanted to store the **times** that the animals were fed?



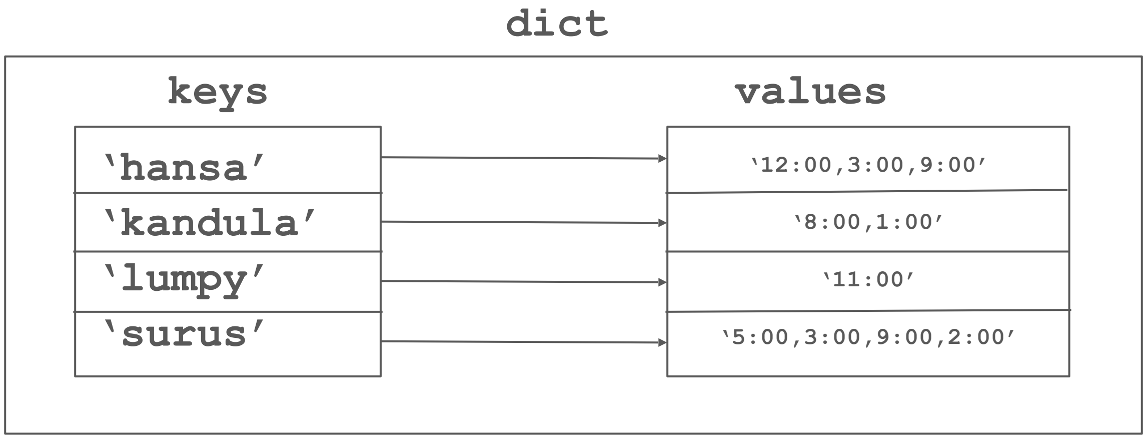
dict

keys	**values**
‘hansa’	‘12:00,3:00,9:00’
‘kandula’	‘8:00,1:00’
‘lumpy’	‘11:00’
‘surus’	‘5:00,3:00,9:00,2:00’

Attempt #1: Animal – Feeding Times Dictionary

- animal name ⟶ **feeding times**
- string ⟶ **string**

What if we wanted to store the **times** that the animals were fed?



dict

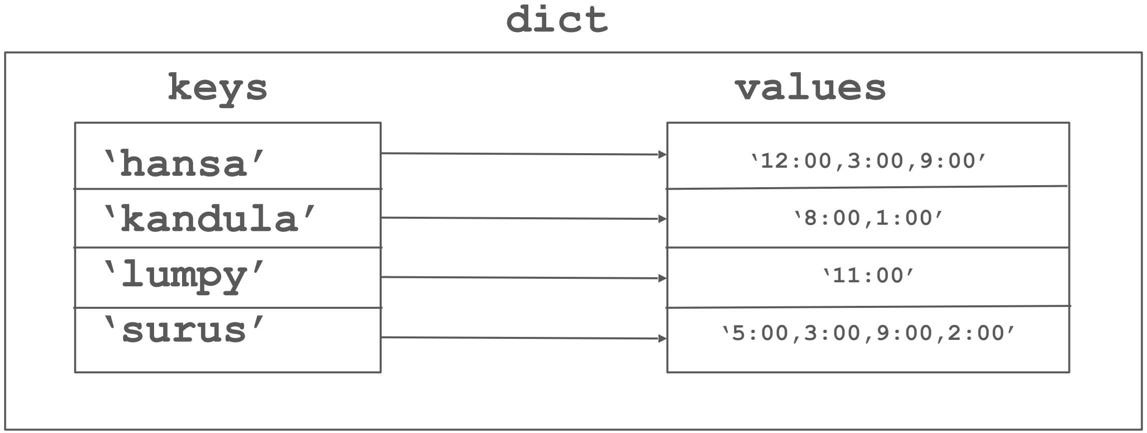
keys	values
'hansa'	'12:00,3:00,9:00'
'kandula'	'8:00,1:00'
'lumpy'	'11:00'
'surus'	'5:00,3:00,9:00,2:00'

Times are not easily accessible!

Attempt #1: Animal – Feeding Times Dictionary

- animal name ⟶ **feeding times**
- string ⟶ **string**

What if we wanted to store the **times** that the animals were fed?



dict

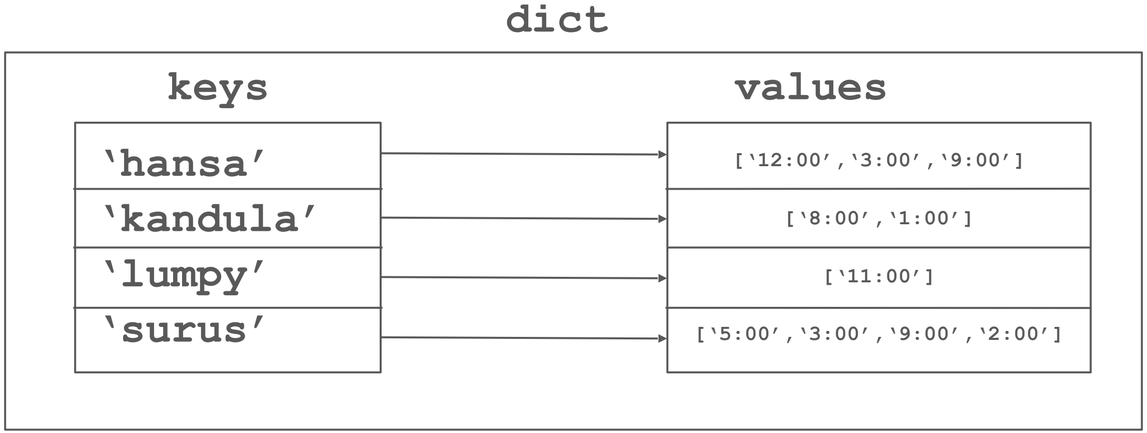
keys	values
‘hansa’	‘12:00,3:00,9:00’
‘kandula’	‘8:00,1:00’
‘lumpy’	‘11:00’
‘surus’	‘5:00,3:00,9:00,2:00’

But those times look like a data type we know of......

Attempt #2: Animal – Feeding Times Dictionary

- animal name ⟶ **feeding times**
- string ⟶ **list[string]**

What if we wanted to store the **times** that the animals were fed?



dict

keys	values
‘hansa’	[‘12:00’,‘3:00’,‘9:00’]
‘kandula’	[‘8:00’,‘1:00’]
‘lumpy’	[‘11:00’]
‘surus’	[‘5:00’,‘3:00’,‘9:00’,‘2:00’]